IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Group Art Unit 1742

In re

Patent Application of

Laxmi C. Tandon, et al.

Application No. 10/685,097

Confirmation No. 5500

Filed: October 10, 2003

Examiner: Deborah Yee

"HIGH TENSILE STRENGTH GRAY IRON ALLOY"

DECLARATION OF LAXMI C. TANDON
PURSUANT TO 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Laxmi C. Tandon, declare as follows:

1. I currently reside at 3508 Zermatt Court, Rockford, Illinois 61114, United States of America.

2. I am the Chief/Sr. Metallurgist of Gunite Corporation ("Gunite"), which is the owner of the above-referenced patent application ("Application"). I am also a joint inventor of the subject matter disclosed in the Application.

3. I obtained a Bachelor of Science degree in Metallurgical Engineering from Banaras Hindu University, India, in 1963. I also obtained a Master of Science degree in Materials Science from State University of New York at Stony Brook in 1977. Further, I

obtained a Professional Degree (consisting of Ph.D. level courses) in Mineral Engineering (Extractive Metallurgy) at Columbia University, New York City in 1978.

4. I have been involved in metallurgy for 42 years and have worked with gray iron alloys for 25 years. During this time, I have created several new and improved gray iron alloys. While I have been employed with Gunite, it has sold at least 6 types of brake drums totaling over 30 million brake drums manufactured from many of my various new and improved gray iron alloys. Accordingly, I have an excellent understanding of the large variety of gray iron alloys and braking components that exist in the marketplace.

5. I have reviewed pending claims 1-37 of the Application as they currently stand in the Submission Accompanying the Request for Continued Examination filed herewith.

6. I understand that the Examiner has rejected claims 1-37 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,948,353 ("Lawrence").

7. I also understand that the Examiner contends that Lawrence discloses gray iron alloys having compositions with constituents whose weights stated as percentages ("wt%") are in ranges that overlap those recited by claims 1 to 37. I understand that the Examiner believes it would be obvious to one of ordinary skill in the art to select the claimed alloy ranges from the disclosure of Lawrence since Lawrence has the same utility (brake drum) and similar properties of high strength and wear resistance.

8. I further understand that the Examiner admits that the prior art does not teach the inclusion of Type A flake graphite and carbon equivalent of 4.1 to 4.25%, but concludes that the undisclosed subject matter would be expected since the compositional limitations are closely met. In addition, I understand that the Examiner contends that Lawrence teaches 0.2 to 0.5% chromium ("Cr") in at least one sample and that Lawrence has a broader teaching that does not include Cr, thereby meeting Applicant's dependent claims reciting less than 0.2% Cr.

9. I have reviewed Lawrence and disagree with the Examiner's contentions above.

10. Lawrence and the Application relate to braking components, but address and attempt to solve completely different issues. Lawrence addresses gray iron compositions for brake components with increased wear resistance and hardness, while the Application addresses gray iron alloys for brake components with high tensile strength relative to conventional gray iron alloys that maintain machineability and thermal properties comparable to conventional gray iron alloys. Lawrence's gray iron compositions with increased wear resistance and hardness lack the machineability of conventional gray iron and, in fact, have decreased machineability. Lawrence provides gray iron compositions with increased wear resistance and hardness by including one or both of tin ("Sn") and Cr. The Application describes gray iron alloys with high tensile strength relative to conventional gray iron alloys that maintain machineability and thermal properties comparable to conventional gray iron by including specific amounts of molybdenum ("Mo") and copper ("Cu") and by having a specific range of Carbon Equivalent ("C.E."). Lawrence has no need for increasing the tensile strength because Lawrence discloses a composite brake drum having a steel outer shell. The steel shell has sufficient tensile strength to sustain braking forces applied thereto during braking. To the contrary, non-composite brake drums (i.e., no steel outer shell) use gray iron for the braking surface, and that gray iron must provide a sufficiently strong surface to withstand the braking forces. In the past, non-composite gray iron brake components were manufactured heavier and thicker than components made with the gray iron alloy described in the Application to provide the necessary strength (I discuss this below with reference to Appendix B). The Application discloses improved gray iron alloys that have an increased tensile strength relative to conventional gray iron brake components, therefore enabling lighter and thinner non-composite gray iron brake components that maintain machineability and thermal properties comparable to conventional brake components. Accordingly, increasing the wear resistance and hardness of the gray iron alloys, as taught by Lawrence, would adversely affect the manufacture of brake components, particularly, by decreasing machineability.

11. Independent claims 1, 11, 18 and 20 each recite copper of about 0.3% to about 0.6%, molybdenum of about 0.6% to about 0.8%, and carbon equivalent of about 4.10% to about 4.25%.

12. In the Office Action dated April 26, 2005 (the "First Office Action"), and as previously stated, the Examiner contends that Lawrence discloses compositions having constituents whose wt% ranges overlap those recited in claims 1-37. The Examiner further contends that such overlap renders Applicant's composition unpatentable because it would be obvious to one of ordinary skill in the art to select the claimed ranges from the broader disclosure of the prior art (Lawrence), since the prior art (Lawrence) has the same utility and similar properties of high strength and wear resistance. I respectfully disagree with this contention. With respect to the prior art and the gray iron alloys of the Application having similar properties, this is clearly inaccurate as described above in paragraph 10. The compositions of Lawrence have increased wear resistance and hardness and the gray iron alloys of the Application have high tensile strength. These properties are different. Accordingly, it *would not* be obvious to one of ordinary skill in the art to select the ranges claimed in claims 1-37. Particularly, the claimed ranges of Cu, Mo, and C.E. would not be obvious to one of ordinary skill in the art.

13. The claimed range of about 0.3% to about 0.6% of Cu achieves the desired results of the gray iron alloys of the Application and this range is not obvious from the disclosure of Lawrence. I have determined from research that the desired high tensile strength for gray iron alloy occurred when Cu was in the claimed range of about 0.3% to about 0.6%. I have attached a graph as Appendix A showing the change in tensile strength as it relates to Cu. From the graph, the range of about 0.3% to about 0.6% of Cu clearly shows high and acceptable tensile strength. Tensile strength drops to unacceptable levels as the amount of Cu moves outside the claimed range of about 0.3% to about 0.6%. The lower tensile strength outside the claimed range of Cu is insufficient for braking components made from gray iron alloys. Lawrence claims a wide range of Cu, particularly 0.3% to 1.0%, but only utilizes a small range of Cu, particularly 0.6% to 0.7%, in the illustrated examples. See Col. 2, line 63 - Col. 3, line 8; Col. 4, lines 1-9; Col. 4, lines 15-23. This leads me to believe that for Lawrence, the range of 0.6% to 0.7% of Cu provided the desired results of the gray iron composition. The broader claimed range of 0.3% to 1.0% is not supported by the examples provided, and Cu in amounts outside the range of 0.6% to 0.7% may not provide Lawrence's compositions with the increased hardness he desired for increased wear resistance. Accordingly, as one of ordinary skill in the art, I believe that Lawrence only teaches the narrower range of 0.6% to 0.7% of Cu. The 0.6% to 0.7% range of Cu in Lawrence's examples is outside the claimed range of Cu in the Application and I have

discovered through research, which is supported by the graph in Appendix A, that an amount of Cu greater than 0.6% *would not* provide a gray iron alloy with high tensile strength.

14. The claimed range of about 0.6% to about 0.8% of Mo for the gray iron alloys of the Application is not obvious from the disclosure of Lawrence. My experimentation to achieve high tensile strength in gray iron alloy showed that desired results occurred when Mo was in the range of about 0.6% to about 0.8%. I have attached as Appendix B documentation of my experiments relating to different ranges of Mo and how these ranges affect the tensile strength of gray iron alloy. Page 1 of Appendix B identifies the purpose, test criteria, and conclusion associated with the experimentation, page 2 illustrates a pair of graphs illustrating test results of brake drum samples made from gray iron alloy with various ranges of Mo, and page 3 shows a first Weibull analysis report conducted with Mo in the range of 0.4% to 0.5% and a second Weibull analysis report conducted with Mo in the range of about 0.6% to about 0.8%. The top graph on page 2 illustrates brake drum samples with Mo in the range of 0.4% to 0.5% (below the claimed range of Mo) and the acceptance criterion of 200 cycles. In this experimentation, a cycle is summarized as follows: a brake drum travels at a predetermined speed, the brake drum is brought to a complete stop at a deceleration rate of $24 ft/sec^2$, and the predetermined speed of the brake drum increases throughout the test until the brake drum is unable to perform. The speed of the brake drum is at 30 mph for 50 cycles, 50 mph for 50 cycles, 60 mph for 100 cycles, and 70 mph for 200 cycles. Failure points of the samples are identified by triangles. From the top graph, the majority of the samples (those to the left of the 200 cycle criterion line) are clearly unacceptable. Most samples fail prior to the acceptance criterion and those samples that do pass the acceptance criterion do so directly on or slightly beyond the 200 cycle acceptance point. The mean number of cycles to failure with Mo in the range of 0.4% to 0.5% is 172.9 cycles (see page 3 of Appendix B). The bottom graph on page 2 illustrates brake drum samples with Mo in the range of about 0.6% to about 0.8% (the claimed range of Mo) and the acceptance criterion of 200 cycles. Again, the failure points for the samples are identified by triangles. In my experimentation using Mo in the about 0.6% to about 0.8% range, all samples exceeded the acceptance criterion by a substantial number of cycles. The mean number of cycles to failure with Mo in the range of about 0.6% to about 0.8% is 248.9 cycles (see page 3 of Appendix B). Accordingly, utilizing an amount less than the claimed range of about 0.6% to about 0.8% of Mo would provide gray iron alloy brake components with low cycles to failure, thereby providing an

unacceptable failure rate due to the low tensile strength generated by the low amount of Mo. Lawrence does not teach the about 0.6% to about 0.8% range of Mo disclosed and claimed in the Application. Lawrence claims a wide range of Mo, particularly 0.25% to 0.75%, but only utilizes a small range of Mo, particularly 0.35% to 0.45%, in the illustrated examples. This leads me to believe that the range of 0.35% to 0.45% of Mo provided the results of the gray iron composition desired by Lawrence. Accordingly, as one of ordinary skill in the art, I believe that Lawrence only taught the narrower range of 0.35% to 0.45% of Mo. The 0.35% to 0.45% range of Mo taught by Lawrence's examples is outside the claimed range of Mo in the Application and I have shown through experimentation and the graphs in Appendix B that an amount of Mo less than about 0.6% would not provide gray iron alloys with sufficiently high tensile strength. Lawrence's range of Mo is inappropriate for making gray iron alloys with high tensile strength. Again, this is also confirmed by my experimentation and graphs included in Appendix B.

15. In addition to the claimed ranges of Cu and Mo not being obvious, the disclosure of Lawrence teaches away from the claimed ranges of the Application. Particularly, with reference to paragraph 10 above, Lawrence is attempting to achieve a completely different result than the Application. Accordingly, I and others of ordinary skill in the art would understand that obtaining a gray iron alloy with increased wear resistance and hardness versus obtaining a gray iron alloy with highly increased tensile strength would require completely different experimentation and different compositions to achieve the particular desired properties. Lawrence utilizes the range of 0.6% to 0.7% of Cu and 0.35% to 0.45% of Mo in the illustrated examples to achieve the desired increased wear resistance and hardness, even though his claims refer to broader ranges. The broader ranges of Cu and Mo claimed by Lawrence teach away from the claimed ranges of Cu and Mo in the Application by suggesting that a relatively broad range for Cu and Mo provides an acceptable gray iron. But as discussed above in paragraph 13, any amount of Cu above the claimed range of about 0.3% to about 0.6% of Cu adversely affects the tensile strength of the gray iron alloy. Likewise, as discussed above in paragraph 14, an amount of Mo below the claimed amount of about 0.6% to about 0.8% of Mo adversely affects the tensile strength of the gray iron alloy. Accordingly, the broader ranges of Cu and Mo claimed in Lawrence show that Lawrence did not appreciate the claimed ranges of the Application and, in fact, Lawrence's broad ranges teach away from the claimed ranges of the Application.

16. Further, I have found that the presence of Cu and Mo in their claimed ranges in the Application has a cooperative effect in the gray iron alloys of the Application to provide several new and unexpected results. Particularly, the tensile strength of the gray iron increases, without substantially increasing the hardness and reducing the machineability of the alloy in comparison to conventional gray iron. See p. 10, ¶ 26 of the Application. Such new and unexpected results are not realized in Lawrence. More specifically, Lawrence does not address tensile strength mainly because Lawrence discloses a composite brake drum having a steel outer shell surrounding the gray iron. The steel shell is used as the support for the gray iron braking surface, thereby reducing the importance of the gray iron having high tensile strength. The cooperative effect achieved by the presence of Cu and Mo in their claimed ranges in the Application achieves other new and unexpected results. More particularly, the tensile strength of the gray iron alloy increases sufficiently to permit the manufacture of lighter and thinner brake drums. With reference to Appendix C, brake drums are shown to illustrate these new and unexpected results. Drawing #1 illustrates the composite brake drum disclosed in Lawrence. Drawing Set #2 illustrates in the left figure a rear brake drum made from a gray iron alloy having the claimed ranges of Cu and Mo in the Application, while the right figure shows a rear brake drum made of conventional gray iron alloy. A clear difference in thickness of 0.31 inches (for the alloy of this Application) versus 0.50 inches (for a conventional alloy) can be seen between the brake drums. That is, the brake drum made from the claimed gray iron alloy is only 62% of the thickness of the brake drum made from conventional gray iron alloy. The reduced thickness achieved by the higher tensile strength gray iron alloy having the claimed ranges of Cu and Mo permits the manufacture of a lighter overall brake drum. Drawing Set #3 illustrates a pair of front brake drums. The left brake drum is made from gray iron alloy having the claimed ranges of Cu and Mo and the right brake drum is made of conventional gray iron. Similarly to Drawing Set #2, the brake drum made from the gray iron alloy with the claimed ranges of Cu and Mo is much thinner than the brake drum made of conventional gray iron. A clear difference can be seen in thickness of 0.25 inches (for the alloy of the Application) versus 0.50 inches (for the conventional alloy) in the front brake drums. That is, the brake drum made from the claimed gray iron alloy is only 50% of the thickness of the brake drum made from conventional gray iron alloy. Drawing #1, Drawing Set #2, and Drawing Set #3, show the clear difference between

composite and non-composite brake drums, and the clear difference between brake drums made from the claimed gray iron alloy and conventional gray iron alloy.

17. In the first Office action (mailed April 26, 2005), the Examiner admits that the prior art, including Lawrence, "does not teach...carbon equivalent of 4.1 to 4.25%", but concludes that such carbon equivalent would be expected. I respectfully disagree with this contention. Lawrence does not appreciate the significance of carbon equivalent, as I have stated in the disclosure and claims of the Application, and the impact it has on the gray iron alloy. Carbon equivalent is never discussed in Lawrence. I and others of ordinary skill in the art would not and could not conclude that the carbon equivalent claimed in the Application would be expected from a reference that does not teach or suggest any type of carbon equivalent. In addition, as indicated in the Application, "the amount of carbon in the inventive alloy is balanced against the amount of silicon to achieve about 4.1% to about 4.25% carbon equivalent, which is necessary to maintain good thermal conductivity" (¶20, page 8 of the Application). I have found through experimentation that such a range of carbon equivalent has a cooperative effect with other elements in the claimed gray iron alloys to provide several new and unexpected results including, but not limited to, increasing the tensile strength of the gray iron alloy without adversely increasing the hardness and adversely reducing the machineability of the alloy in comparison to conventional gray iron. A gray iron alloy with a carbon equivalent lower than about 4.1% can adversely reduce the thermal properties and the machineability of the gray iron alloy, and a carbon equivalent of higher than about 4.25% can decrease the tensile strength of the gray iron alloy. Accordingly, the claimed carbon equivalent range of about 4.1% to about 4.25% is significant.

18. For these and other reasons, I do not believe Lawrence teaches, suggests, or makes obvious the subject matter of independent claims 1, 11, 18 and 20 or the subject matter of dependent claims 2-10, 12-17, and 21-33, which respectively depend from independent claims 1, 11, and 20.

19. Independent claims 19 and 34 recite a Cu range of about 0.40% and a Mo range of about 0.7%. Accordingly, my statements set forth above in connection with claims 1, 11, 18, and 20 regarding Cu and Mo are also relevant to claims 19 and 34. Lawrence definitely did not

consider the wt% of Cu and Mo claimed in independent claims 19 and 34. Accordingly, I do not believe Lawrence teaches, suggest, or makes obvious the subject matter of independent claims 19 and 34 or the subject matter of dependent claims 35-37, which depend from independent claim 34.

20. I also do not believe Lawrence teaches, suggests, or makes obvious the subject matter of independent claims 1, 11, 18, 19, 20, and 34 because every composition of gray iron disclosed in Lawrence includes one or both of tin (Sn) and chromium (Cr), while the pending independent claims make no mention of either Sn or Cr. Independent claims 1, 11, 18, 19, 20, and 34 of the Application include the language "consisting essentially of", which I understand refers to a composition that includes the listed ingredients and only those unlisted ingredients ***that do not materially affect the basic and novel properties of the invention.*** Lawrence discloses compositions that have materially different chemistries from the compositions claimed in independent claims 1, 11, 18, 19, 20, and 34. More particularly, Lawrence discloses gray iron compositions that include one or both of Sn and Cr. Lawrence discloses that the castings formed of the gray iron compositions of the invention, including at least one or both of Sn and Cr, "exhibit moderately increased hardness...the level of tin included in the composition creates a finer microstructure [and]...[t]he higher levels of Cr...are believed to contribute to the increased hardness...of the gray iron compositions." Lawrence, Col. 3, Lines. 9-28. According to Lawrence, both Sn and Cr have a material effect on the basic and novel properties of the compositions disclosed in Lawrence and, therefore, would have a material effect on the basic and novel properties of the gray iron alloys disclosed in the Application. Consequently, the presence of one or both of Sn and Cr disclosed in every composition of gray iron in Lawrence should not be ignored or minimized. In the final Office action dated August 17, 2005, the Examiner addresses the claim language "consisting essentially of" in the Application and the material effect that Sn has on gray iron compositions by stating "[i]t is the examiner's position that this difference is merely the omission of an element with the obvious consequent loss of its function". I respectfully disagree with this contention by the Examiner. The function of Sn in gray iron compositions is to promote pearlitic matrix structures. With reference to Appendix D, the gray iron alloys claimed and disclosed in the Application have a fully pearlitic matrix structure that was achieved *without adding Sn.* Sn would have little affect on the base gray iron alloys because the microstructure of the gray iron alloys claimed and disclosed in the Application

are already fully pearlitic. In other words, no function is lost by the omission of Sn (as contended by the Examiner). Accordingly, the Examiner's position regarding Sn does not apply to the claimed gray iron alloys of the Application. For these reasons, and the reasons set forth above and others, I believe Lawrence does not teach, suggest, or make obvious the subject matter of claims 1-37.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like are punishable by fine and imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1/16/2006 — Laxmi C. Tandon

Date — Laxmi C. Tandon

GUNITE Corporation

HIGH TENSILE STRENGTH GRAY IRON ALLOY

Product Engineering Test Data on Low Molybdenum Drums

Purpose:

This report will show the difference in durability in cast iron brake drums from molybdenum content above and 0.6%.

Brake Drum Certification Test:

This test establishes a uniform method for dynamometer testing of ground vehicle truck, trailer and bus brake drums for vehicles in excess of 10,000 G.V.W. The purpose of this practice is to establish brake system capabilities with regard to drum characteristics and life.

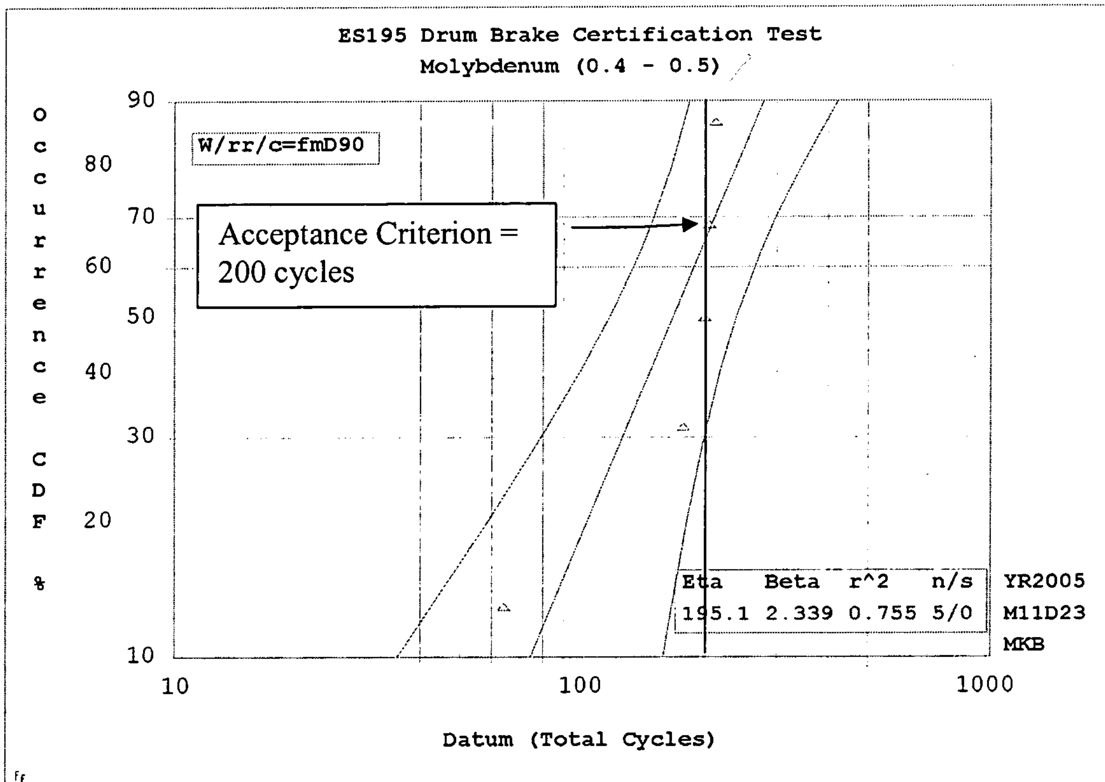
The only difference between the two sets of test was the content of molybdenum. All the tests were run on the same dynamometer at Link Testing Laboratories, Inc in Detroit, MI. The test load was for 20,000 pound gross axle weight and a rolling radius of 20.8 inches. The brake drums were the 9006 and the brake lining was the MB21 Q+. The acceptance criterion is 200 total durability cycles.

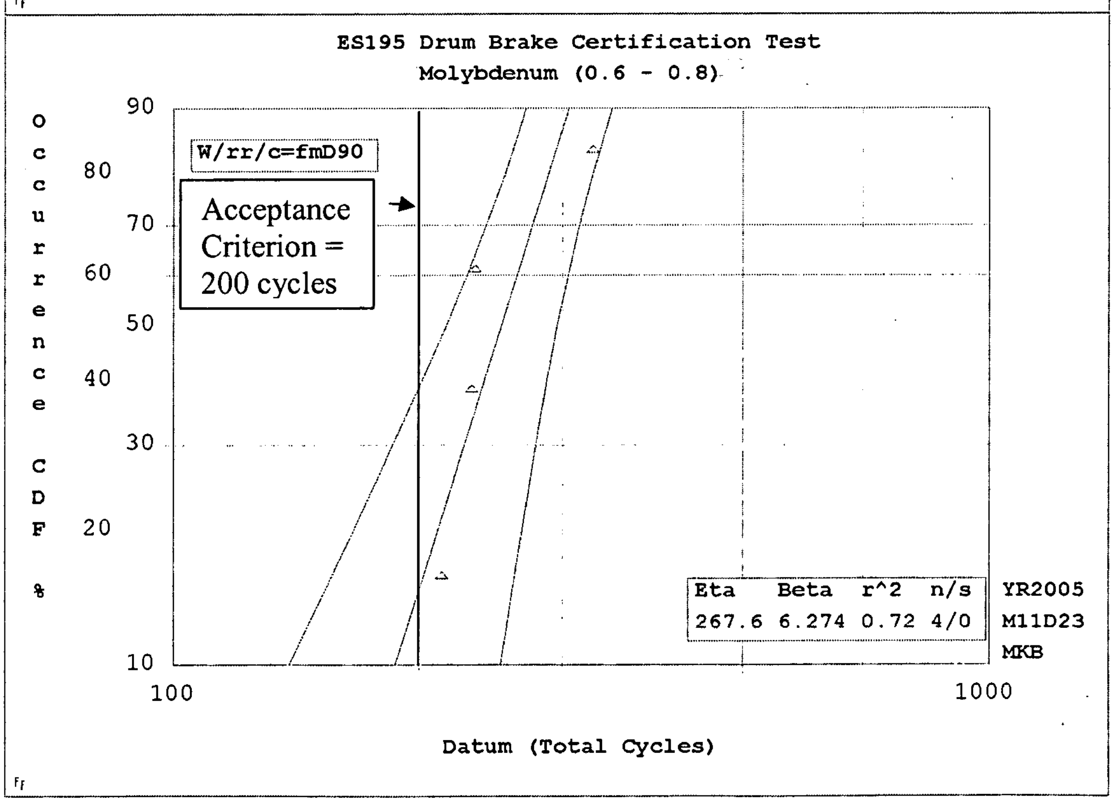
Testing Conclusion:

The characteristic value from the Weibull analysis for brake drums with (0.4 - 0.5) molybdenum is 195.1 cycles which is below the 200 cycles required. The characteristic value from the Weibull analysis for brake drums with (0.6 - 0.8%) molybdenum is 267.6 cycles which is above the 200 cycles required. The drums with (0.6 - 0.8%) molybdenum has a 37% improvement in characteristic value over the drums with (0.4 - 0.5%) molybdenum.

The B10 criterion is the prediction that at this level 90% of the product will be performing satisfactory. Brake drums with (0.4 - 0.5%) molybdenum had a B10 life of 74.53 cycles compared to brake drums with (0.6 - 0.8%) molybdenum had a B10 life of 186.9 cycles.

GUNITE Corporation





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Weibull Analysis Report
Set 1 - Molybdenum (0.4 - 0.5%)
Date: M11-D23-YR2005

ES195 Drum Brake Certification Test
Correlation(r)=.8689073 r^2=.755 ccc^2=.8184 r^2-ccc^2= -.0634 (r^2<ccc^2!)
Characteristic Value=195.1 Weibull Slope=2.339 Method=rr
Mean=172.9 (>121.4<246.1) Std. Deviation=78.52
Point Quantity=5 (susp=0)
c=fmD90 EtaL=138.9 EtaU=274 BetaL=1.169 BetaU=4.681

B%	95% Lower	Datum	95% Upper
10	35.09	74.53	158.3
50	116.6	166.8	238.6
63	138.5	194.6	273.3

Weibull Analysis Report
Set 2 - Molybdenum (0.6 - 0.8%)
Date: M11-D23-YR2005

ES195 Drum Brake Certification Test
Correlation(r)=.8485281 r^2=.720 ccc^2=.8021 r^2-ccc^2= -.0821 (r^2<ccc^2!)
Characteristic Value=267.6 Weibull Slope=6.274 Method=rr
Mean=248.9 (>211.3<293.1) Std. Deviation=46.27
Point Quantity=4 (susp=0)
c=fmD90 EtaL=232.8 EtaU=307.6 BetaL=3.539 BetaU=11.12

B%	95% Lower	Datum	95% Upper
10	138.7	186.9	251.9
50	215.5	252.4	295.6
63	232.6	267.3	307.4

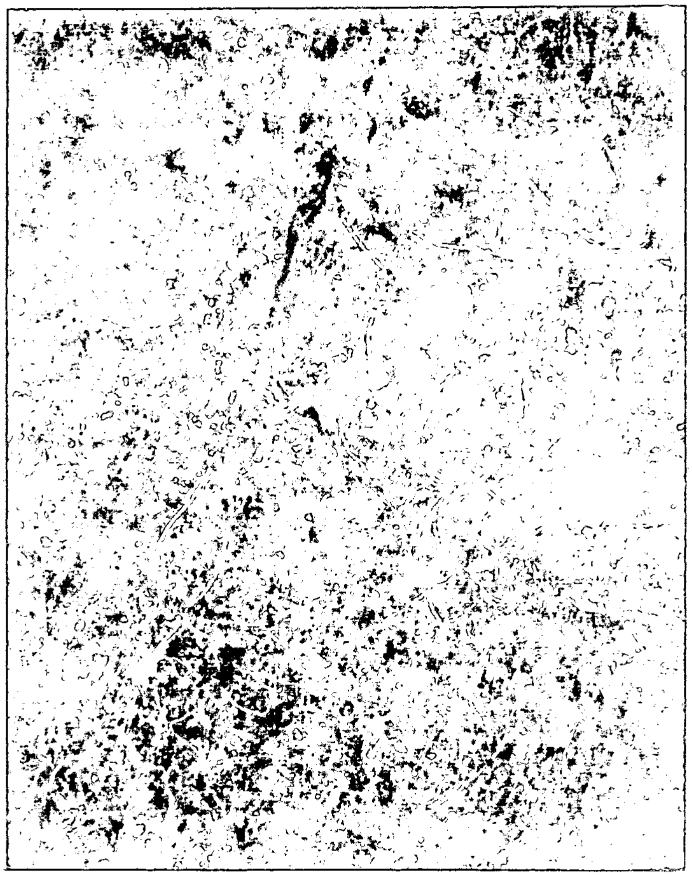


Fig.1 Photomicrograph of Mo-Cu Gray Iron Brake Drum Showing Fully Pearlitic Matrix (Black Background), Special Phases in White (Not Ferrite), Magnification 100X, Etched with 3% Nital

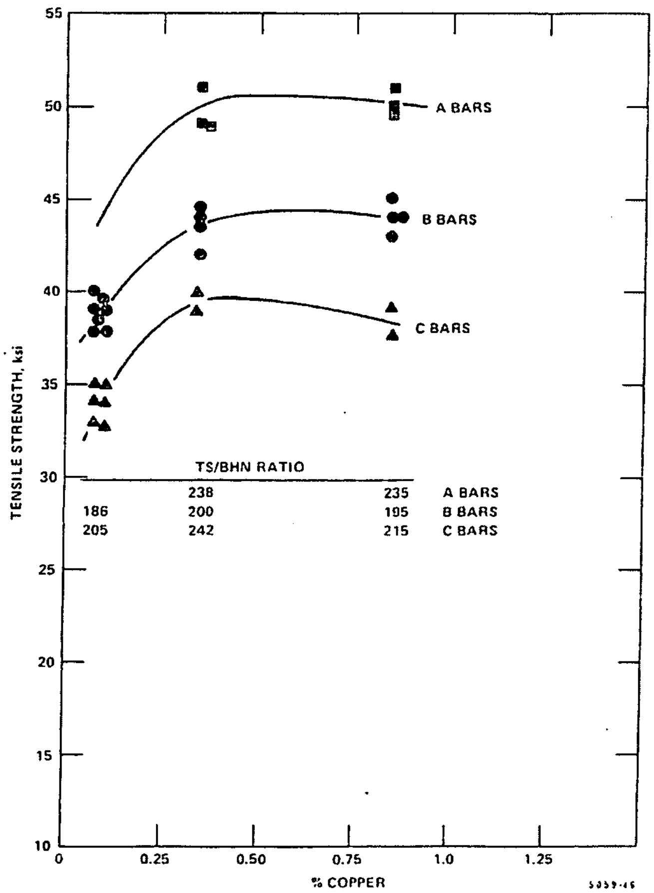
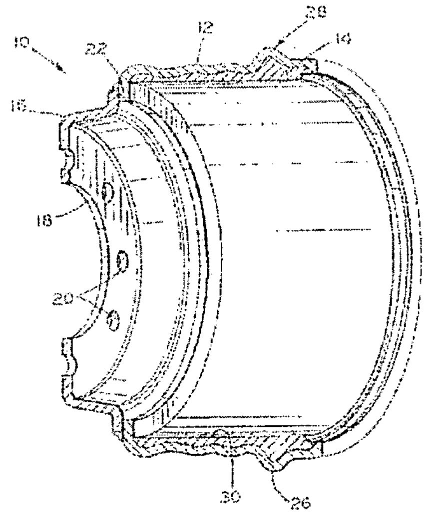
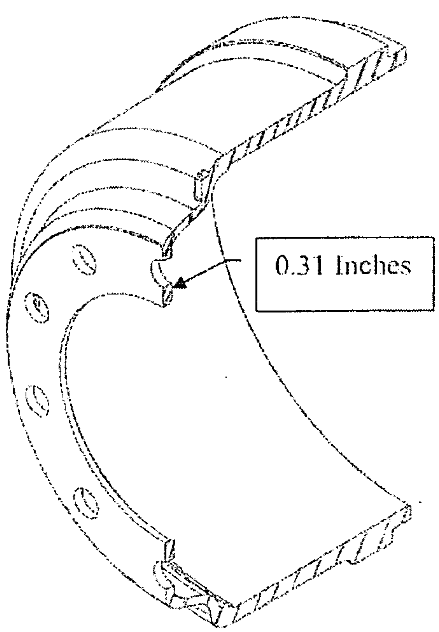


Fig. 21. Effect of copper content and section size on gray iron tensile strength.

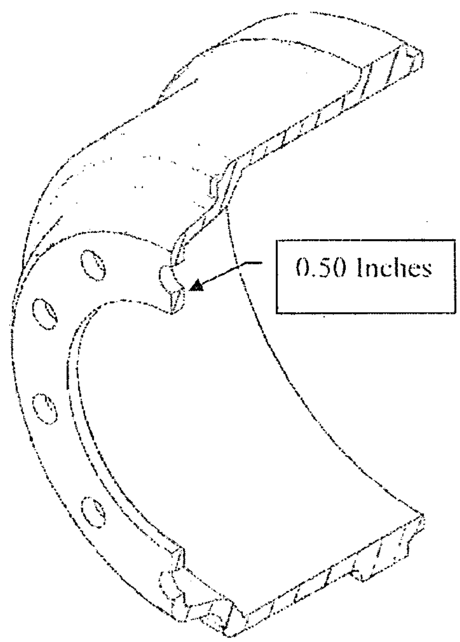
U.S. Patent Sep. 7, 1999 5,948,353



Drawing #1
Brake Drum (Composite)

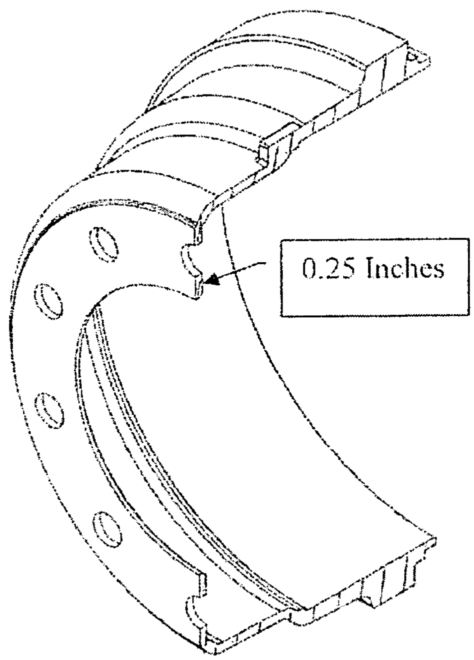


Lightweight Brake Drum (Rear)
Non-Composite

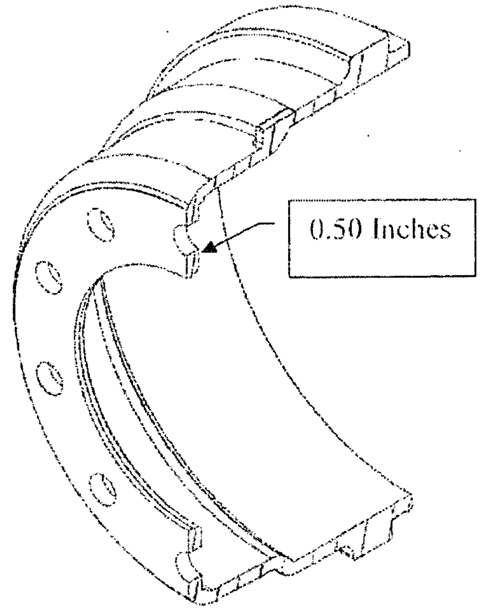


Conventional Brake Drum (Rear)
Non-Composite

Drawing Set #2



Lightweight Brake Drum (Front)
Non-Composite



Conventional Brake Drum (Front)
Non-Composite

Drawing Set #3